

# Collider Physics Program at BNL

*Hong Ma*  
*Physics Department*

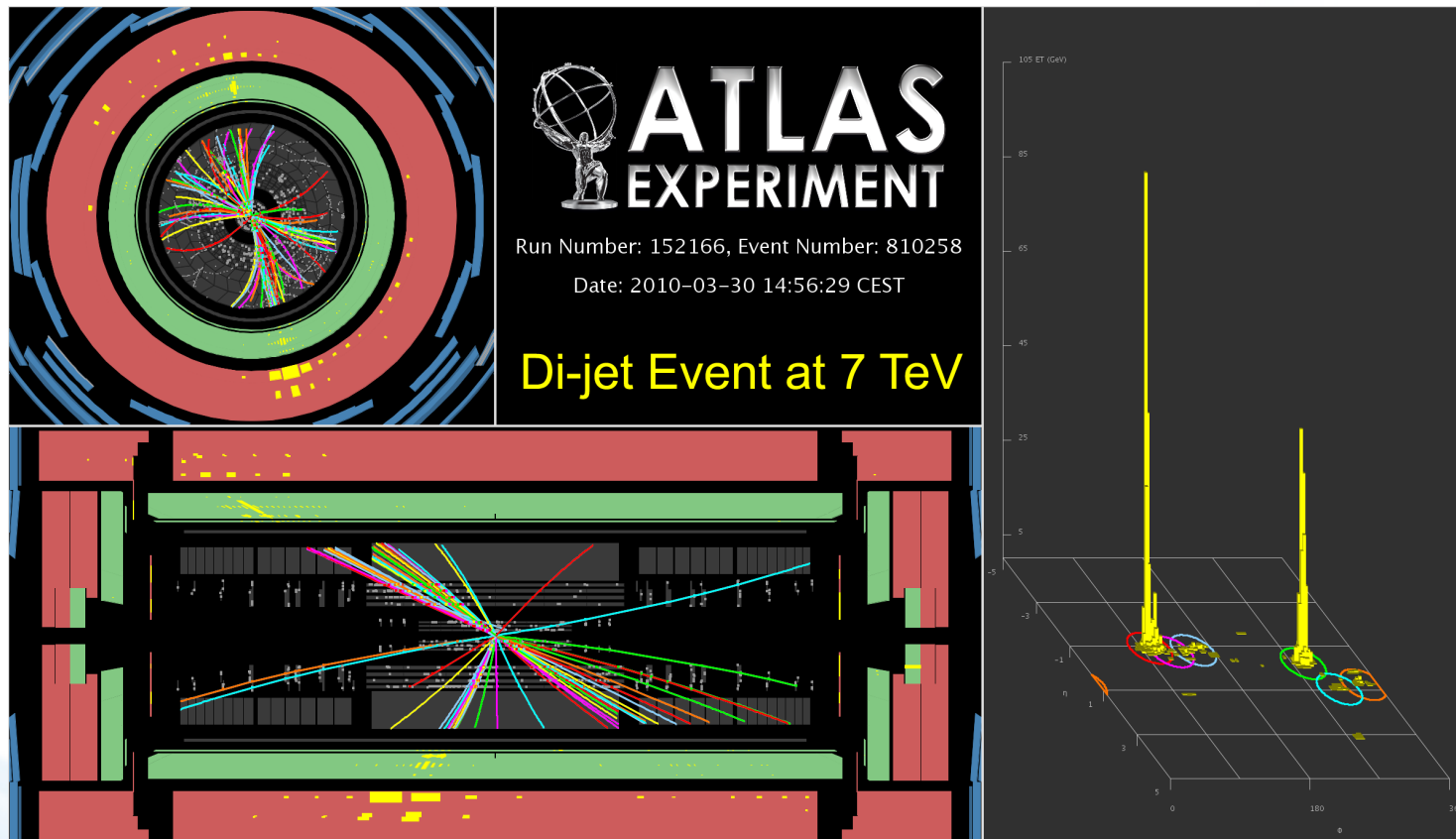


# Outline

- Current efforts in ATLAS & D0
- Recent accomplishments
- Plan for the next years

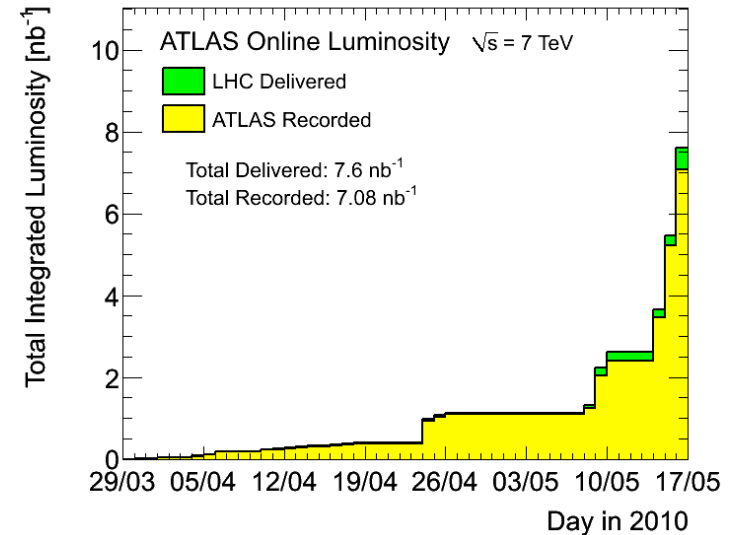
Details will be discussed in the breakout session

BNL's role in D0,	A. Patwa
ATLAS detector op and perf,	S. Rajagopalan
ATLAS Physics Analysis,	M. Begel
ATLAS Detector Upgrade R&D,	F. Lanni
ATLAS Tier-1 at BNL,	M. Ernst

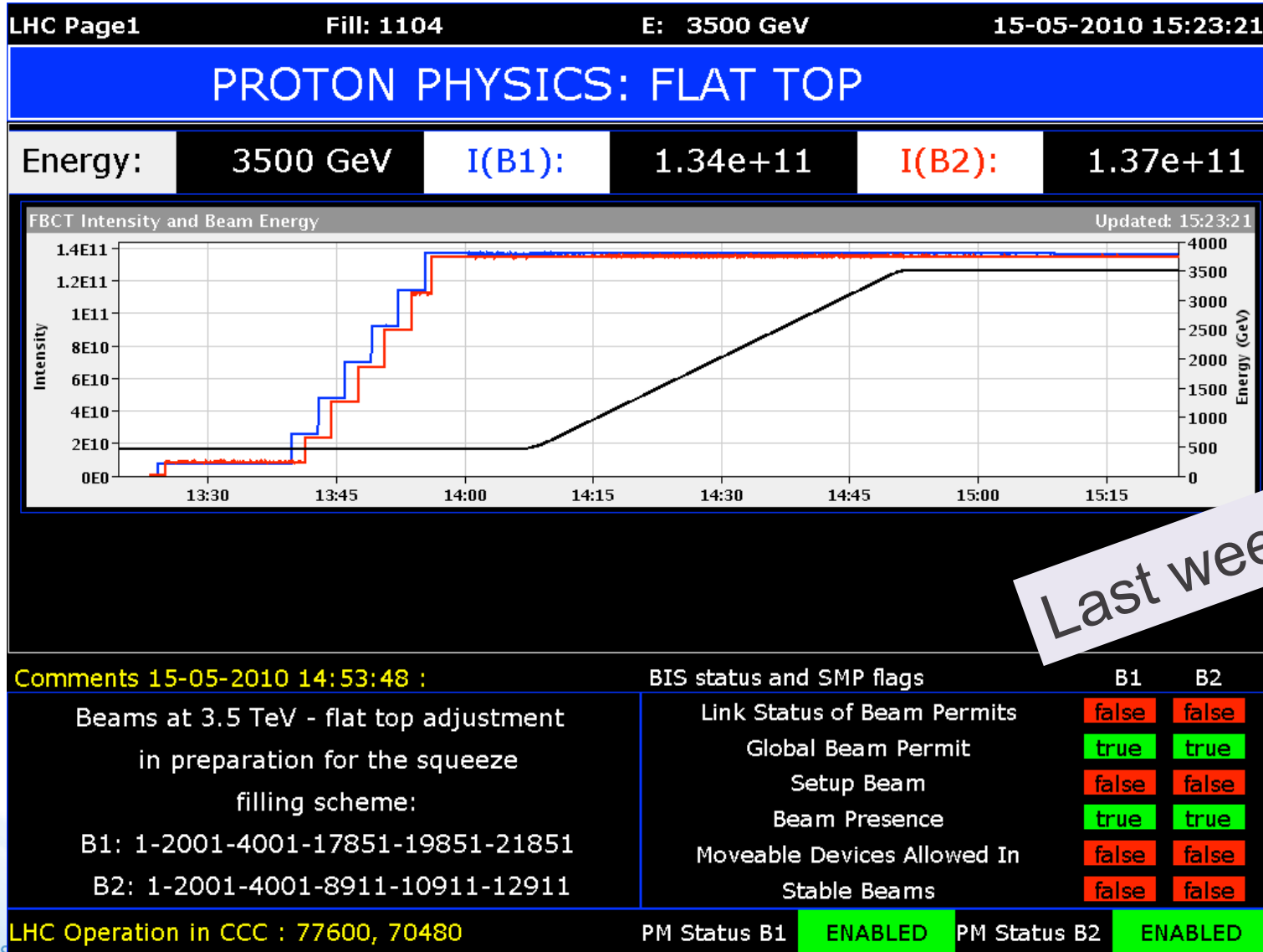


# ATLAS & LHC Status

- 20 Nov 2009: first beams circulating in the LHC
- 23 Nov 2009: first collisions at  $\sqrt{s} = 900$  GeV
- 8 Dec 2009: collisions at  $\sqrt{s} = 2.36$  TeV
- 27 Feb 2010: machine operation starts again
- 19 Mar 2010: first (single) beams ramped up to 3.5 TeV
- 30 March: first collisions at 3.5+3.5 TeV
- Luminosity is improving steadily
  - Current peak luminosity,  $6 \times 10^{28}/\text{cm}^2/\text{sec}$ ,
  - Total integrated Luminosity  $\sim 7 \text{ nb}^{-1}$
- Plan for 2010-2011
  - 2010: run at 7 TeV with L up to  $10^{32}/\text{cm}^2/\text{sec}$ , collect  $100 \text{ pb}^{-1}$
  - 2011: run through the fall at 7 TeV, goal is  $1 \text{ fb}^{-1}$  integrated
- 2012: year-long shutdown to carry out repairs to allow  $\sim 14$  TeV
- 2013: start running at  $\sim 14$  TeV
- Beyond 2013: may be clarified in June

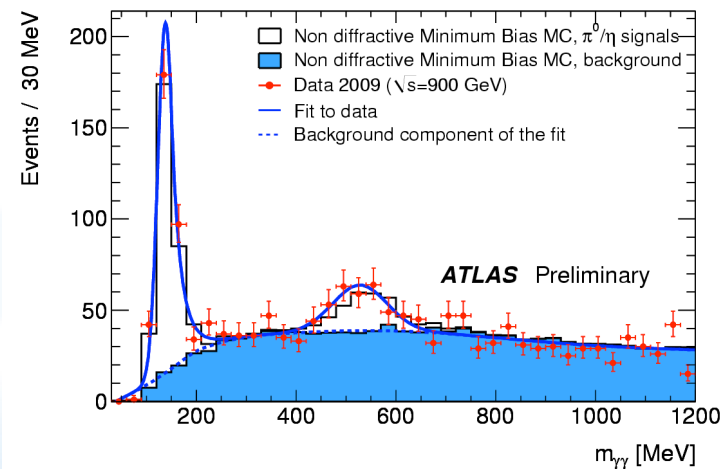
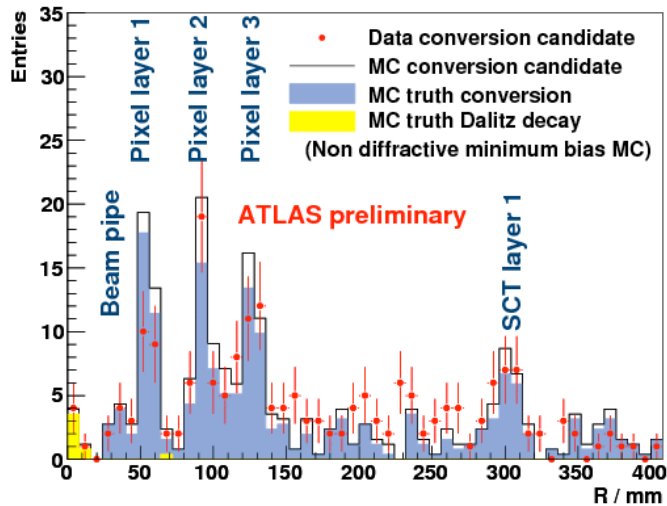
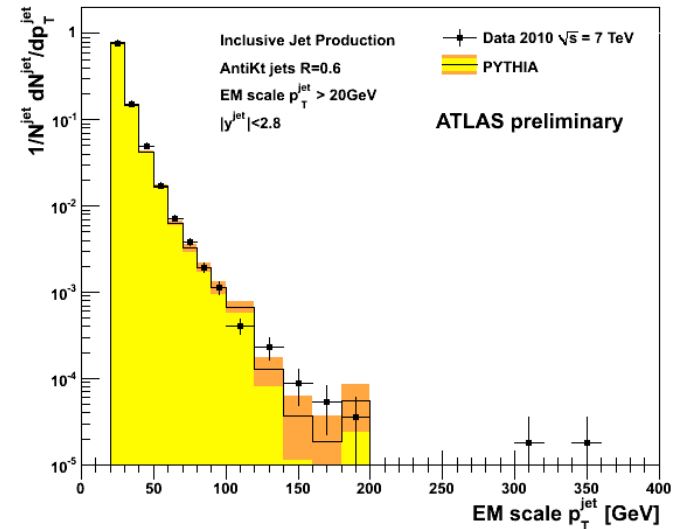
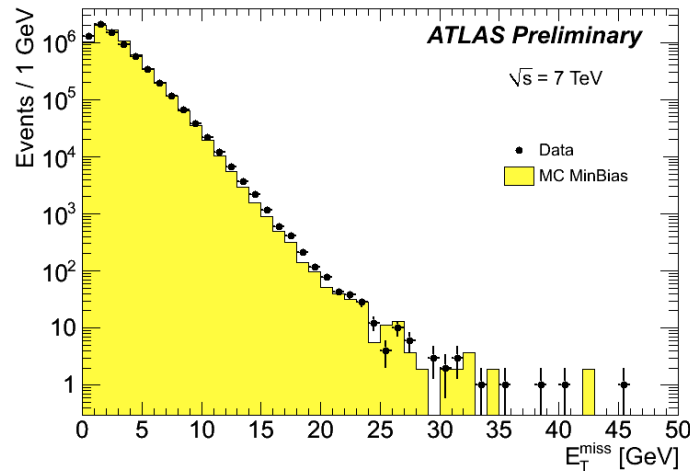


6 bunches per beam at  $\sim 2 \times 10^{10}$  protons/bunch  
Peak Luminosity =  $6 \times 10^{28} / \text{cm}^2/\text{s}$

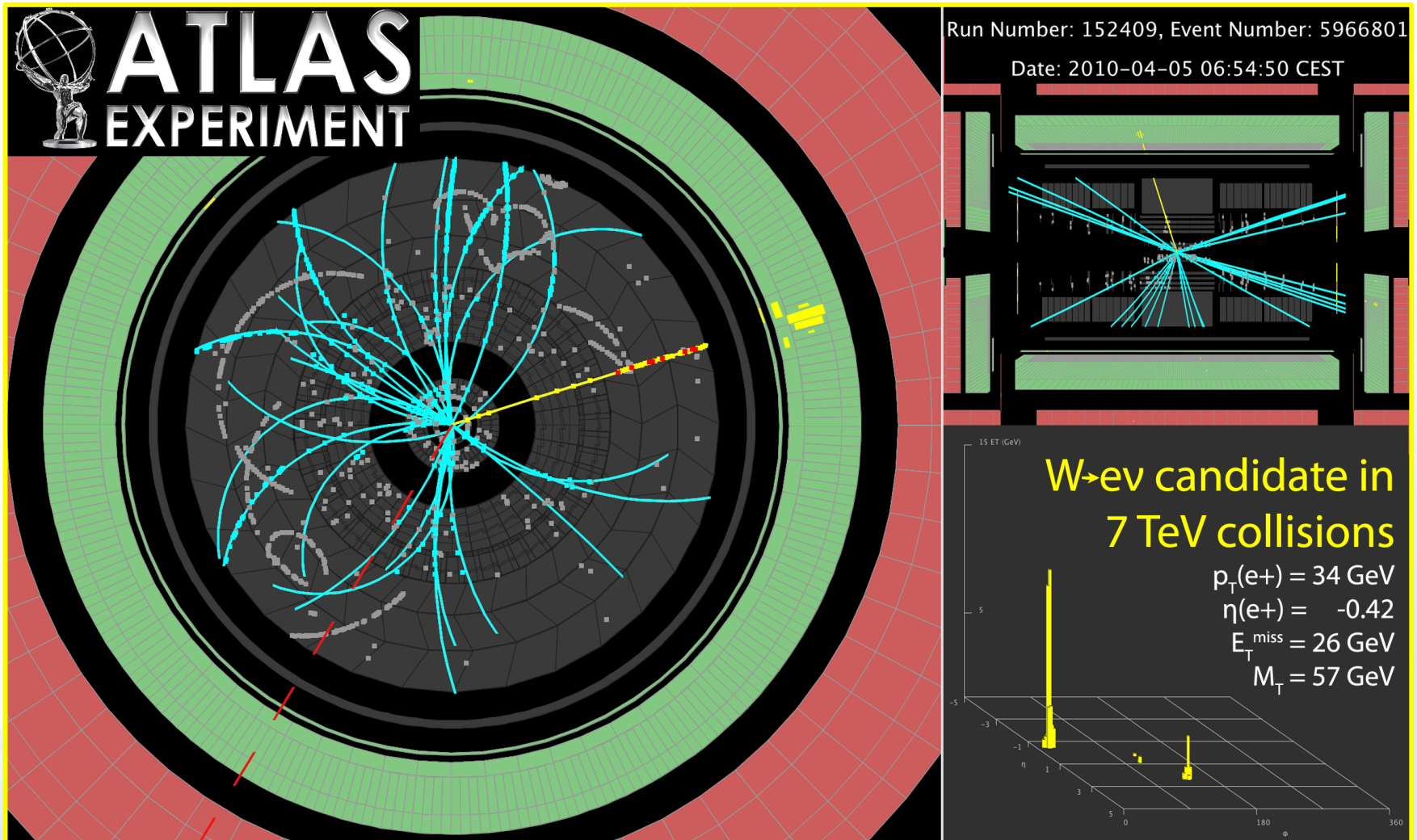


Last weekend

# Early collision data has already demonstrated excellent performance



# One of the first $W \rightarrow e\nu$ candidates

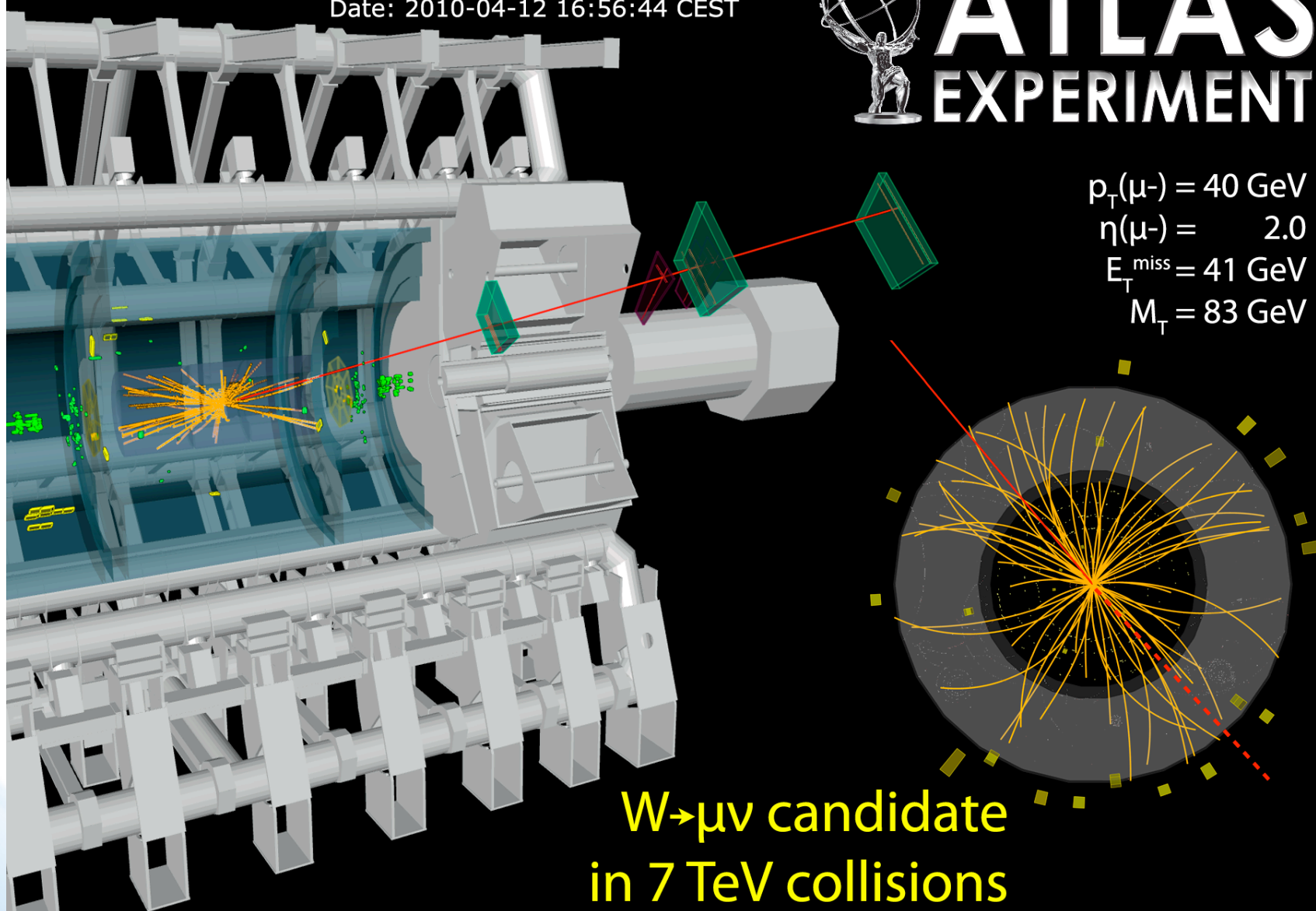


Run: 152845, Event: 3338173  
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# ATLAS EXPERIMENT

$p_T(\mu^-) = 40 \text{ GeV}$   
 $\eta(\mu^-) = 2.0$   
 $E_T^{\text{miss}} = 41 \text{ GeV}$   
 $M_T = 83 \text{ GeV}$



# Collider Physics at BNL

ATLAS Authors: 43

8.7% of US, 1.9% of ATLAS

Core program: 18

Operations: 17

Others: 8

FTEs funded by Operations: 41.6

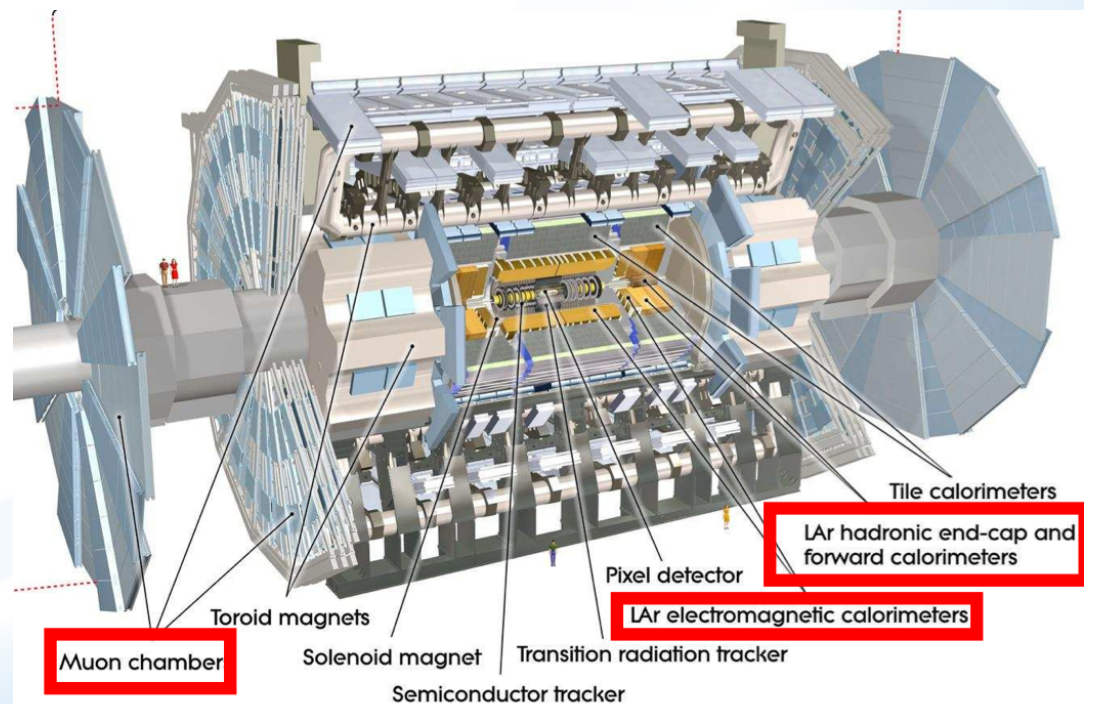
- A major contributor to ATLAS since its beginning
  - Based on previous pioneering work on hadron collider experiments
    - ISR in 70's, D0 since 1980's, GEM for SSC
  - Strong detector R&D program and physics interests.
- Essential strategy of the ATLAS program at BNL:  
from detector to software to performance to physics
  - Major responsibilities in software & performance matched to detector & computing expertise, guided by physics interests & analysis activities
  - Physics analysis benefits from extensive knowledge of the detector.
- Close collaboration with other US institutions on detector and physics analysis
  - Enabling university groups to use our infrastructure and expertise
- Well recognized in ATLAS
  - Major roles in detector, software and physics.

# BNL Contributions to ATLAS detector construction and operation

- Cathode Strip Chamber
  - Production of all chambers
  - On-detector electronics
- Technical Coordination
  - Project Office(2001-9)
- Trigger
  - Trigger menu
  - Jet trigger
  - Trigger coordination
- Zero Degree Calorimeter
  - (BNL Nuclear Physics)

- LAr Calorimeter

- Barrel cryostat, cryogenics
- Signal feedthroughs, cold electronics
- Frontend electronics and crates
- Low voltage power supplies
- System tests



# Current BNL ATLAS Detector, Software, Performance and Physics Activities

Detector M&O	Software	LAr Calorimeter Ma,Snyder,Lanni, Majewski, Tarrade Damazio, Chen		Muon CSC Polychronakos, Assamagan,Adams Tcherniatine, Nikolopoulos		Technical Coord. Polychronakos		Trigger Rajagopalan Begel,Damazio Redlinger		Core Software Rajagopalan Assamagam, Ma,Snyder, Protopopescu		Dist. Comp/DM Wenaus + 10 software professionals	
	Performance	e-gamma Snyder, Tarrade		Jet/EtMiss Majewski ,Paige, Begel ,Ma, Pleier		Muon Performance Adams,Assamagan, Nikolopoulos,Yamamoto				τ-id Protopopescu			
	Early Physics	QCD dijet Begel,Majewski Paige		Z/γ(*)+jets Begel, Paige, Yamamoto, Adams		Inclusive μ's Adams, Redlinger		di-boson Gadfort, Pleier, Ma		tT di-lepton(including τ) Mete, Searcy, Snyder, Rajagopalan, Protopopescu, Pleier			
	Long Term Physics	Inclusive SUSY (l+Et+jets) Redlinger,Paige,Gibbard		H->ττ Protopopescu, Patwa		H->4lepton, charged Higgs Assamagan, Lee, Koch Nikolopoulos, Tarrade				new physics with di-boson and tT Gadfort, Pleier,			
	Upgrade R&D	LAr Readout Upgrade Lanni, Takai, Chen		Si Tracker (Strip) Lynn,Pleier		Forward Muon Polychronakos, Tcherniatine, Nikolopoulos							

Color Code: Core funded physicists, US ATLAS Operations funded Professionals, Students, HE-Theory

# Current Roles in ATLAS

- **National Contact Physicist**  
H. Gordon (representing U.S.)
- **Physics Group Conveners**  
K. Assamagan (Higgs)  
G. Redlinger (SUSY)  
P. Steinberg (Heavy Ion, Nucl.Phys)
- **Software Projects**  
H. Ma ( SW Mgmt board for LAr)  
[A. Klimentov](#) (Distr. Computing)  
S. Snyder (Perf Mgmt Board)
- **Liquid Argon Calorimeter**  
F. Lanni (Deputy P. L. for Upgrade)  
H. Ma (LAr Data Preparation )  
S. Majewski (LAr Run Coordinator)
- **Muon Spectrometer**  
V. Polychronakos (CSC manager)
- **Trigger**  
S. Rajagopalan (Deputy Coordinator)  
M. Begel (Jet Trig Group Convener)  
[D. Damazio](#), (Calo Trigger )
- **Upgrade Steering Group**  
F. Lanni (LAr upgrade)

# Core Program & US ATLAS Operations

- Scientific leadership from Core program, engineering and technical resources provided by the US ATLAS Operations Program
- M&O and R&D efforts are completely integrated with US ATLAS planning.
- Roles of BNL core funded personnel in US ATLAS and technical staff (FTE in FY10) working with them
  - T. Wenaus: Physics Support and Computing Manager (~30FTE)
  - V. Polychronakos: TC and Muon (3.85 FTE)
  - F. Lanni: LAr electronics M&O and Upgrade R&D (4.6 FTE)
  - D. Lynn: Si Tracker R&D (2 FTE)
  - H. Ma+others: Analysis Support Center (0.5 FTE)
- Close relationship with Tier-1 computing center at BNL
- US ATLAS operations program mgmt (H. Gordon & Program Office)
- **US ATLAS benefits from a strong BNL ATLAS program**

# Detector Operations and Software

- Continuing our critical detector maintenance and operation responsibilities and software development for LAr Calorimeter and Muon CSC

## Liquid Argon Calorimeter

- Electronics Calibration (F. Tarrade)
- Online access to Conditions database (S. Majewski)
- Run Coordination (S. Majewski)
- Software & Data preparation (H.Ma)
- Low voltage power supply operation, monitoring ([D. Damazio](#))
- New low voltage power supply design and construction (F. Lanni, [H. Chen](#))

## Cathode Strip Chambers

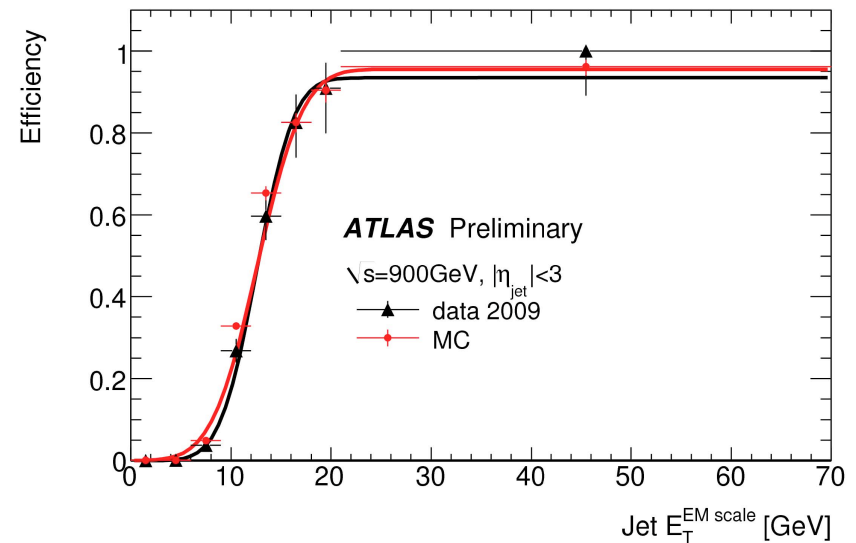
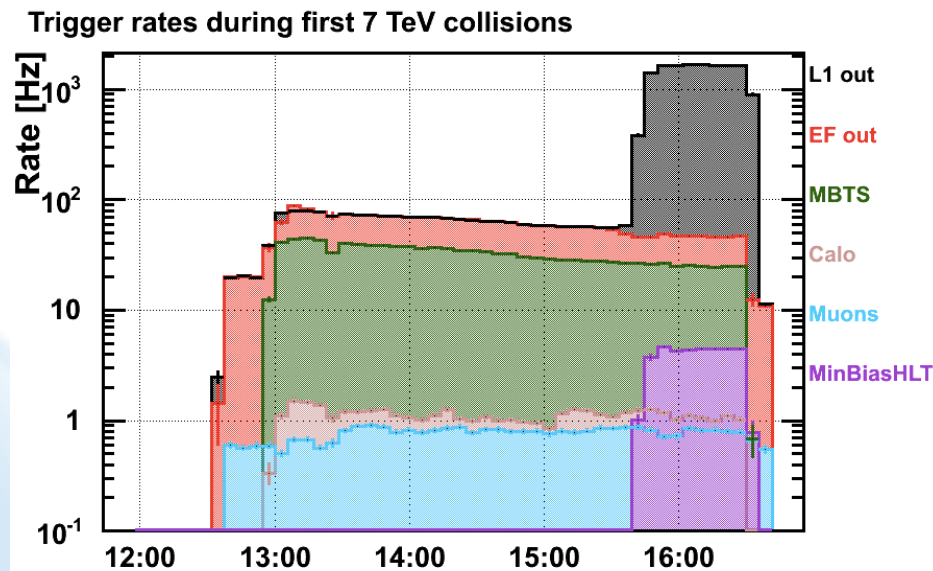
- Full responsibility of the maintenance and operation  
K. Nikolopoulos, V. Polychronakos, [V. Tcherniatine](#)  
98.5% of the detector fully operational.  
Readout fully integrated into ATLAS
- CSC simulation, digitization, calibration and reconstruction  
[D. Adams](#), [K. Yamamoto](#),  
K.Nikolopoulos

# Combined Performance

- A strong participation in combined performance is essential for physics analysis, especially for early data
  - Our interests and contributions to performance studies relate directly to our detector interests, and Tevatron experience
- 
- electron/photons  
(S.Snyder, F. Tarrade)
    - Electron ID,  $\pi^0$  recon
    - Software development
  - Tau (S. Protopopescu)
    - Identification with multi-variant methods
    - Extensive experience from D0
  - Jet performance  
(F.Paige,H.Ma,M.Begel,  
S. Majewski, M-A.Pleier)
    - Jet calibration
    - Jet energy scale using tracks
  - Combined muons  
(D.Adams, K. Assamagen, K.  
Nikilopoulos,K.Yamamoto)
    - Energy loss in calo and isolation
    - Fake rates from  $\pi$ /K decays
    - Muon performance validation

# Trigger: Operation, Software & Performance

- Overall Trigger coordination, include trigger menu (S. Rajagopalan)
  - One of the five principal activity areas in ATLAS
- Jet Trigger coordination (M. Begel)
- Calorimeter trigger software (D. Damazio)
- Software tools for accessing trigger decisions for analysis (M. Begel)
- Trigger efficiencies: muons, Jets (S. Mete, G. Redlinger, M. Begel)



# Physics Application Software Group

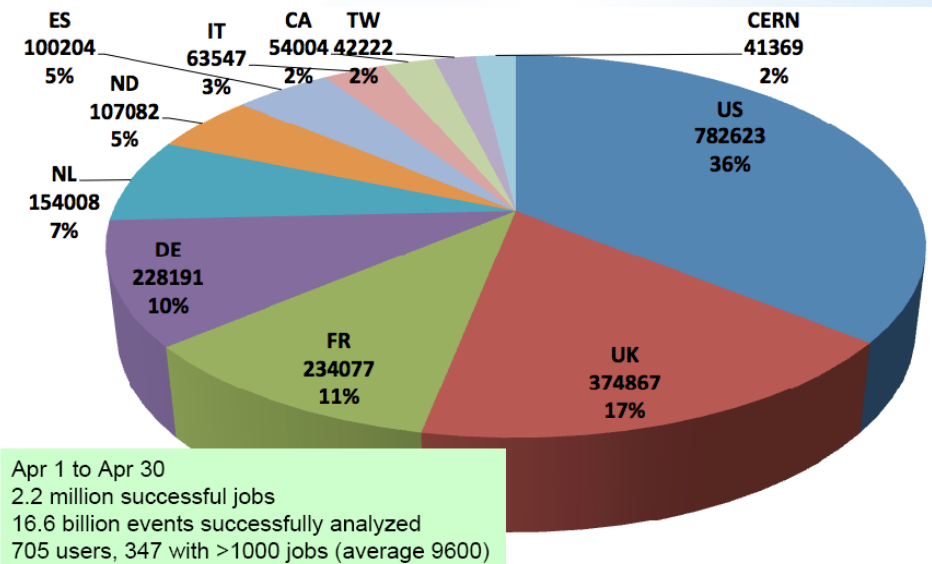
- Focus areas selected for US ATLAS physics analysis impact
- Distributed data management and storage
  - Overall responsibility for ATLAS DDM operations
  - Leading role in DDM design, implementation, management
- Production management and workflow
  - Principal role in developing PanDA (ATLAS Production system)
- Analysis systems and tools
  - ATLAS has chosen PanDA as the primary tool for distributed analysis
- Software support
  - U.S. ATLAS Software Librarian , complementing Tier-1
  - Responsible for ATLAS-wide nightly build and test systems
- Funded by US ATLAS Operations (7.5FTE), OSG/SciDAC(2.5) and core program (1FTE)

# US ATLAS Tier-1 at BNL

- Supported by US ATLAS Operations program, co-exists with RHIC computing facility
  - One of the 10 ATLAS Tier-1's in the world
- BNL Tier-1 is the best in ATLAS in reliability, turnaround, analysis support, and data availability
  - Meeting US pledges to ATLAS
    - 2010: CPU: 49.6 kHS06, DISK: 5.04PB
  - Networking: 1.5GB/s observed in production (0.8GB/s required)
  - Latency from DAQ through Tier 0 reconstruction to distribution to Tier 1 about 4 hours, including BNL and all US Tier 2s
  - Excellent performance in production campaigns
- Additional data storage at Tier-1
  - Complete analysis object data and event summary data are available at Tier-1, beyond the pledged resources.
  - Beneficial especially for early analysis.

# US ATLAS Tier-1 and Analysis

- Excellent performance for user analysis at Tier-1
  - Most popular analysis site in ATLAS
  - Essential for the ATLAS distributed analysis
- Provides limited interactive analysis capabilities for US ATLAS physicists
  - Software support, analysis tools
- BNL Analysis Tier-3
  - Benefits from Tier-1 infrastructure for computing
  - Additional computing resources added for BNL physics analysis.
  - Developing prototype analysis farm.



# ATLAS Physics Analysis

- BNL has built a strong foundation for physics analysis
  - Extensive expertise in detector, software and performance
  - Lead the analysis software tool development
  - Active in physics analysis since the beginning
- Taking leadership roles: ATLAS Physics Working Group Conveners:  
K. Assamagan: Higgs (10/2008), G. Redlinger: SUSY(10/2009) , P. Steinberg(N.P.):Heavy Ion (10/2008)
- Close collaboration with BNL HEP Theory Group
- Our current focus is on the initial data, rediscover the Standard Model, a necessary step before discovering new physics
  - QCD dijets, W/Z observation
  - Measuring di-boson and  $t\bar{t}$  production in lepton and tau channel
- Long term goal: search for new physics
  - Inclusive search for SUSY in Jets+MissingEt, and 1-lepton+Jets+MissingEt
  - Search for Higgs Bosons in leptonic channels.
- Directly involved in a few high priority ATLAS physics analysis with  $100 \text{ pb}^{-1}$

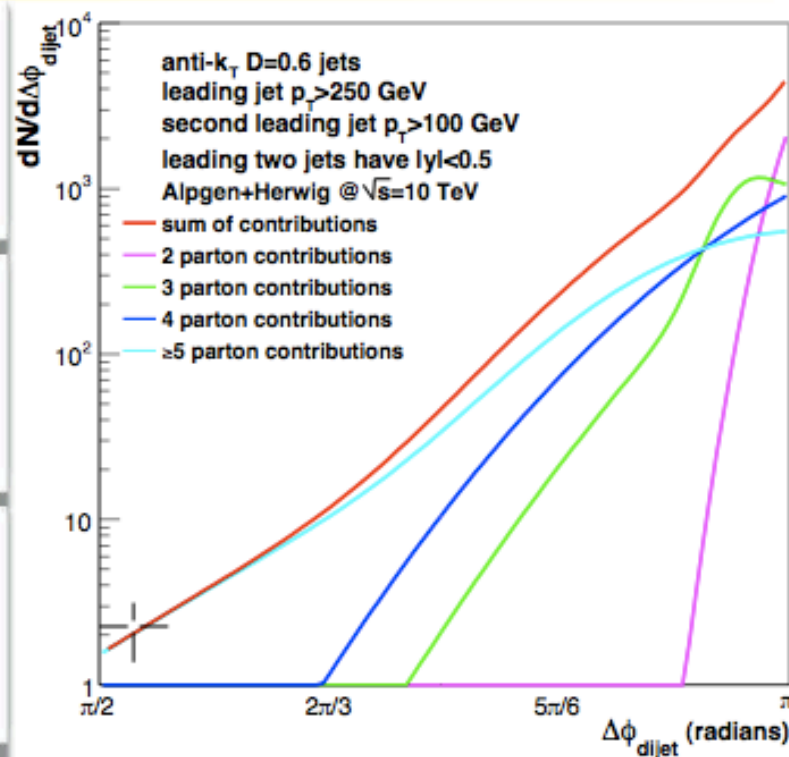
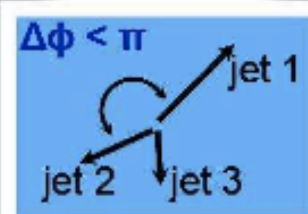
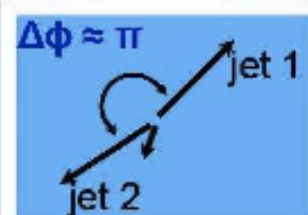
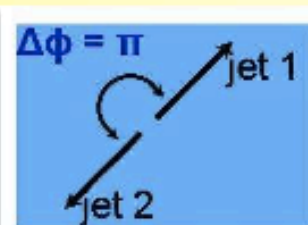
# $\Delta\phi$ in Dijet Events

Begel, Majewski, Paige<sup>†</sup>

- Azimuthal angle between two leading central jets sensitive to higher-order QCD radiation without explicitly measuring additional jets
- test pQCD up to  $\mathcal{O}(\alpha_s^4)$
- validate MC event generators such as Alpgen & Sherpa  $\Rightarrow$  important for searches
- input into Pythia tune

- shape measurement (no uncertainty from luminosity or absolute efficiencies)
- limited sensitivity to JES

- Initiated and led by BNL
- Collaborating with Louisiana Tech, SMU, Stony Brook, Toronto, UC London
- working with 6 students
- two Ph.D. theses (Stony Brook, Toronto)



- Future Activities
  - re-analyze with precision JES and  $[\mathcal{O}(100) \text{ pb}^{-1}]$
  - extend observable into SUSY search  $[\mathcal{O}(0.1 - 1) \text{ fb}^{-1}]$

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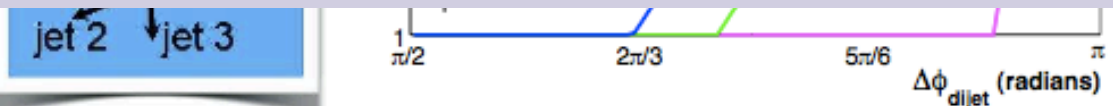
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A Good Example of how analysis effort is carried out by BNL group.

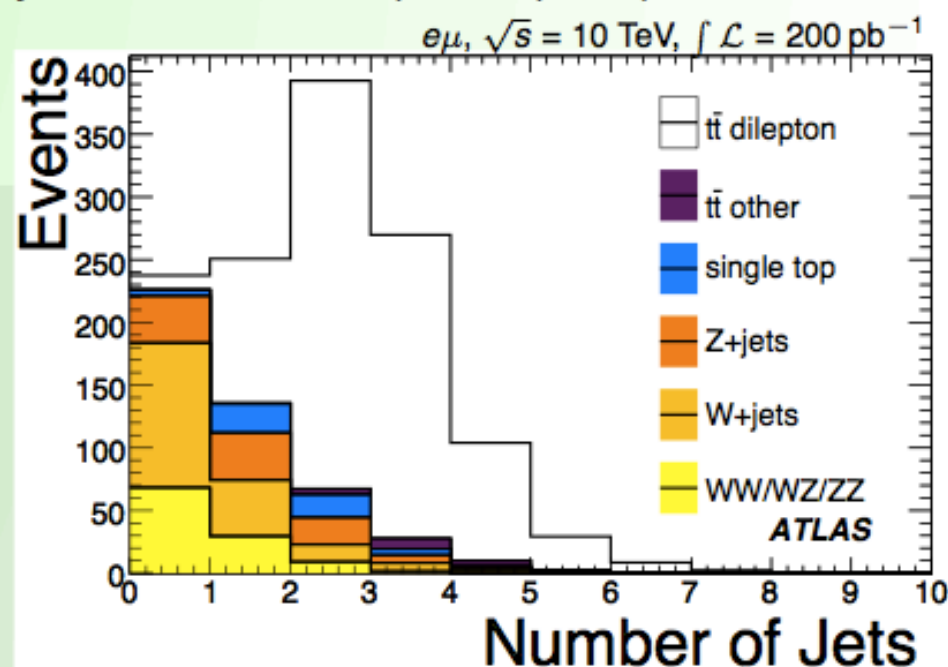
- Work by staff physicists and postdoc
  - With support from the rest of the group
- Benefit from extensive experience in calorimeter, jet performance and Tevatron experience
- Close collaboration with US institutions
- One of the early ATLAS physics results to be published



# Dilepton $t\bar{t}$ Cross Section

- The LHC is a top factory!
  - likely to see signatures of new physics
  - significant background to new physics (e.g., SUSY)
  - BNL experienced in top physics from our DØ efforts
- BNL concentrating right now on dilepton decay channel
  - data quality, luminosity, trigger efficiency, fake rates, and impact of pile-up events
  - in collaboration with Bonn, Glasgow, Iowa State, UC Irvine, New York U., Oregon, Toronto, Stockholm, Yale
  - Mete's Ph.D. thesis effort
- Leverage experience with electrons, muons, and hadronic  $\tau$ 's
  - ⇒ increase sensitivity to new physics such as charged Higgs boson
  - lepton + isolated track
    - collaborating with Illinois & Oregon
    - Searcy's Ph.D. thesis effort
  - lepton + hadronic  $\tau$ 
    - working on  $\tau$  selection criteria
    - with Simon Fraser & LaTech
- Longer-term interests [ $\mathcal{O}(1) \text{ fb}^{-1}$ ]:
  - search for  $t\bar{t}$  resonances
  - test for lepton universality in  $t\bar{t}$  decays; with Johannesburg — Koch's Ph.D. thesis effort

**Assamagan, Koch, Mete, Patwa, Pleier, Protopopescu, Rajagopalan, Searcy, Snyder**



# Analysis Support

- BNL is one of the US ATLAS Analysis Support Centers
  - Aims to provide U.S. ATLAS physicists with broad and deep expertise for complex physics analysis
  - Our ability to provide analysis support is strongly coupled to the level of our own physics analysis activities.
- US ATLAS physics analysis Jamborees at BNL
  - Interact with U.S. ATLAS physicists, facilitate analysis
  - Hosting Analysis Forum discussions
  - Strengthening collaboration on analyses
- Active organizers of ATLAS Physics Workshops of the Americas
- LHC@BNL: joint theory/exp workshop during Jamboree week.
- Next Jamboree/ LHC@BNL: July 12, 2010

## US ATLAS Jamborees at BNL

Date	Participants
Jun, 2006	30
Aug, 2006	34
Dec, 2006	26
May, 2007	35
Aug, 2007	23
Dec, 2007	53
Mar, 2008	21
Jun, 2008	19
Sep, 2008	38
Dec, 2008	28
Mar, 2009	28
Jun, 2009	26
Nov, 2009	23
Feb, 2010	22

Mar, 2009  
June, 2009  
Feb, 2010



# LHC Physics Beyond 2011

- Post-Chamonix estimates
  - 50 fb<sup>-1</sup> data by 2016
  - 300 fb<sup>-1</sup> by 2020
- Precision EW and top measurements
- Search for SUSY at > 1TeV after a few fb<sup>-1</sup> at 14 TeV
- Standard Model Higgs:
  - Exclude with 2 fb<sup>-1</sup> at 14 TeV
  - 5  $\sigma$  Discovery with  $\sim 20$  fb<sup>-1</sup> in full mass range ( $M_H > 115$  GeV)
- Z', graviton with early data
  - Up to 3.5TeV with 10 fb<sup>-1</sup>
- Compositeness, Vector-Boson scattering at high L.
- **LHC lifetime goal remains high**
  - 250-300 fb<sup>-1</sup>/year, total L=3000 fb<sup>-1</sup> by 2030
  - Fully explore the energy frontier, SUSY, extra dim, Z', W'...

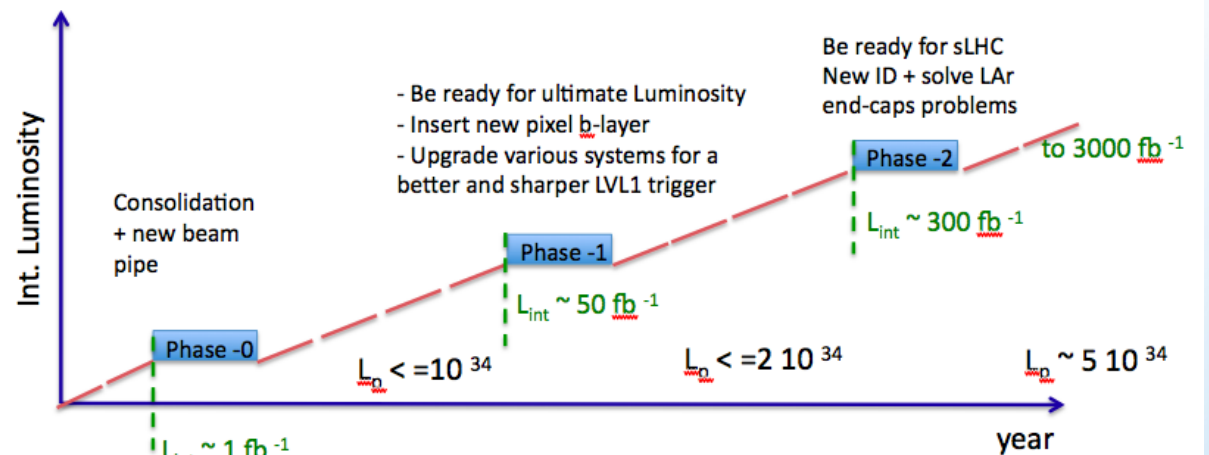
# ATLAS Upgrade

- ATLAS is currently revisiting upgrade strategy
  - Expect updated planning from CERN in summer 2010
  - Phase 1: ~ 2016, Phase 2: ~ 2020

In view of the longer time-scale to Phase-2, consider bringing some of Phase-2 forward to Phase 1:

- Improving performance  
Trigger for example,
- Reduce crowded Phase 2 schedule

Task force will be setup to study possible projects by the end of the year.



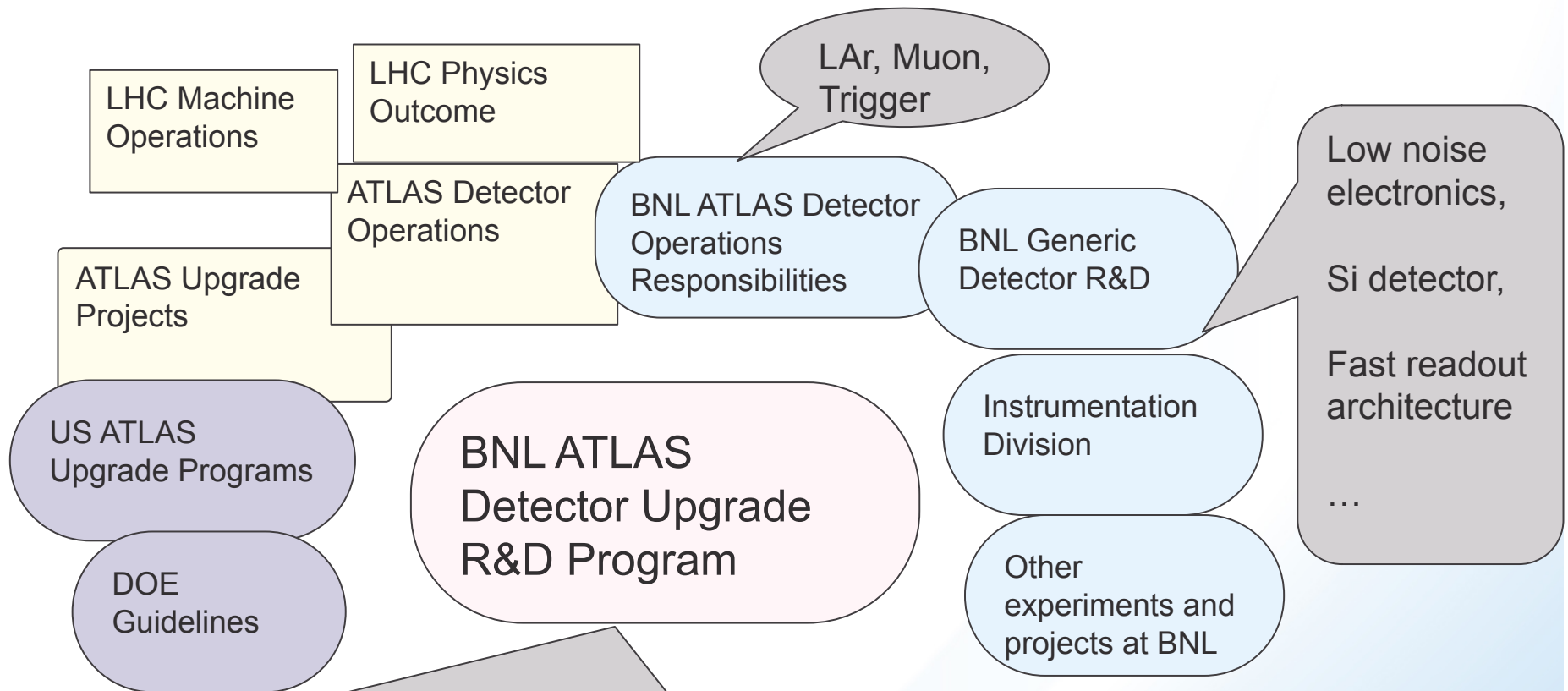
Shutdown requirements :

Phase-0 : 12-14 months (defined by the LHC consolidation)

Phase-1 : 8-9 months (time necessary to install at least the new pixel **b**-layer)

Phase-2 : 18-20 months to install and debug the new ID detector

# Factors Influencing BNL Upgrade R&D Program



- BNL Upgrade R&D program is chosen for its impact on ATLAS experiment, our role in US ATLAS, and our technical expertise.
- Upgrade detector R&D requires long lead time, it is essential to maintain the expertise for the eventual upgrade.

# BNL Upgrade R&D program

- BNL has leadership roles in ATLAS upgrade
  - Forward muon upgrade
    - Recover staged CSC with new detector technology Phase 1
    - BNL proposes to take on the responsibility of readout electronics
  - R&D on LAr readout upgrade
    - Necessary to replace current electronics for phase 2 Phase 2,
    - Investigate possible intermediate upgrade and impact on trigger and physics. to be considered for Phase1
  - R&D on Si Tracker stave design, serial power
    - Extend R&D phase to improve design and components Phase 2
    - Aiming for Si barrel strip production center at BNL
- US LHC Upgrade R&D program is undergoing changes
  - A new generic collider detector R&D program will emerge
  - We plan to compete for funds in the program
- We have a proven track record to take on these upgrade projects allowing for long-term improvements in detector performance and physics reach

# Collaboration with US ATLAS institutions

Through collaboration with US ATLAS institutions, we strengthen the US ATLAS Physics analysis and detector programs

- **Physics analysis**

Track-based jet energy scale:

Berkeley

di-jets :Stony Brook, LaTech, SMU,  
Chicago

tt-bar to dilepton: Oregon, Iowa State,  
UC Irvine, Yale, NYU

di-boson: Columbia, Michigan, Duke

tau final state in tt-bar: LaTech

Higgs search : Arizona, Albany, Tufts,

- **Detector M&O**

LAr Calorimeter: Arizona, Columbia,  
SMU

Muon CSC: Arizona, Irvine, So. Carolina

- **Upgrade R&D**

Forward Muon Spectrometer: Arizona,  
So. Carolina, Washington

Calorimeter Readout: Arizona,  
Columbia, UPenn, SMU

Silicon Strip: LBNL, Yale and NYU

**We have close collaboration with half of the US institutions on physics analysis, detector M&O and R&D**

# BNL's Roles in DØ

- A major contributor to DØ since its inception in 1983
  - Central calorimeter in Run I
  - Forward preshower & project mgmt in Run II
  - Major responsibilities in computing, software and reconstruction
  - Top discovery,  $\tau$ -id and physics, Higgs, QCD, EW, New Phenomena
- Current BNL DØ members and FTEs
  - A. Patwa (100%), S. Snyder (10%), T. Gadfort (10%), M. Begel (10%), M-A. Pleier (10%), S Protopopescu (10%)
- Recent accomplishments
  - $\tau$ -ID Algorithm Group Co-convener: A. Patwa
  - Beyond Standard Model Higgs group convener, A. Patwa
  - Physics Results:

“Search for the SM Higgs boson in  $\tau\tau q\bar{q}$  final state” 4.9 fb<sup>-1</sup>

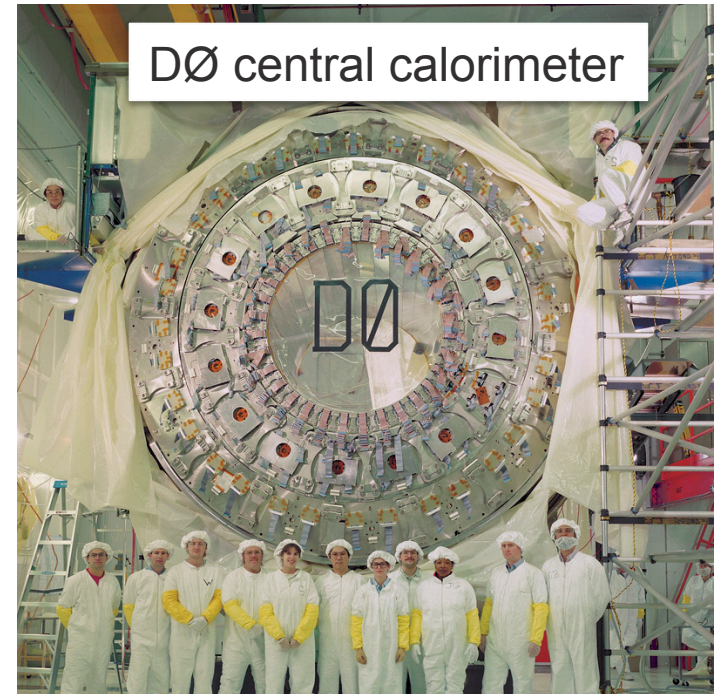
“Search for SM Higgs in  $WH \rightarrow \tau\nu b\bar{b}$  channel” 4.0 fb<sup>-1</sup>

“Combined upper limits on MSSM Higgs boson to  $\tau\tau$  final states” 1-2.2 fb<sup>-1</sup>

“Model Ind. Search for new physics at DØ in final states with leptons” 1.0 fb<sup>-1</sup>

“Combination of DØ top quark mass measurements” 0.1-3.6 fb<sup>-1</sup>

“Dependence of  $t\bar{t}$  cross section on  $p_T$  of the top quark” 1.0 fb<sup>-1</sup>



DØ central calorimeter

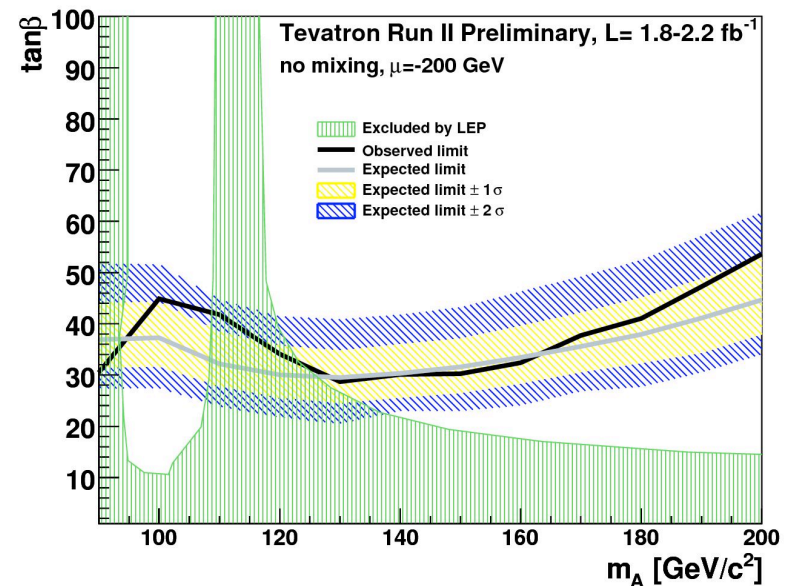
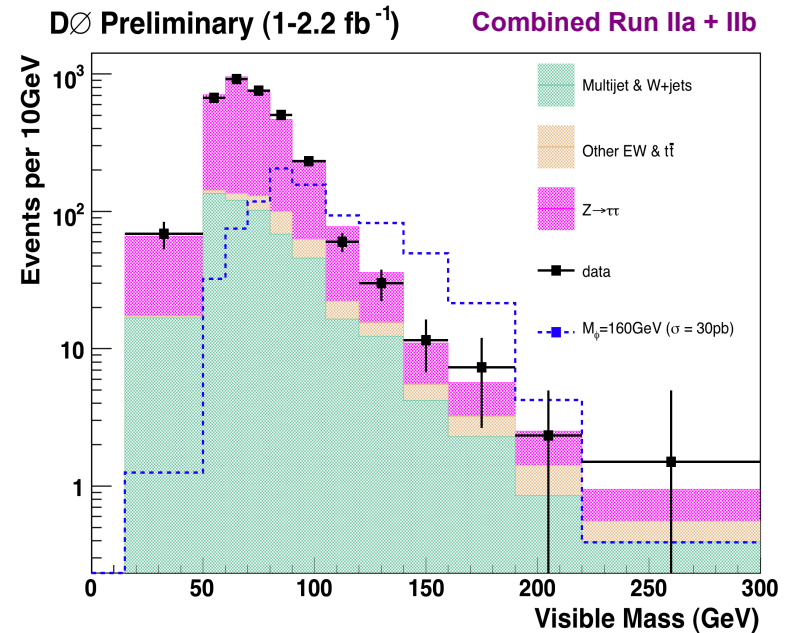


Forward Preshower



# MSSM Higgs: Inclusive $\tau\tau$ Search

- ❖ **Result using 1.0 fb<sup>-1</sup> dataset for  $\tau_\mu\tau_h$ ,  $\tau_e\tau_h$ , and  $\tau_e\tau_\mu$ : PRL 101, 071804 (2008)**
- ❖ **Updated 2.2 fb<sup>-1</sup> result considers  $\tau_\mu\tau_h$** 
  - isolated  $\mu$  separated from  $\tau_h$ : opposite sign
  - $\tau$ -ID NN discriminates hadronic  $\tau$  from jets
- ❖ **No excess in data across visible mass spectrum**
  - Improved exclusion limits in MSSM ( $m_A$ ,  $\tan\beta$ )
  - Dawson, Kilgore (BNL) contributed to theory
- ❖ **New Tevatron (DØ, CDF) combination for  $\tau\tau$  search channels**
  - with a fraction of final dataset, probing interesting region of  $\tan\beta \sim 30$  [ $\mathcal{O}(m_{\text{top}}/m_b)$ ]
  - most stringent limits on  $\tan\beta$
- ❖ **In publication mode with 5.4 fb<sup>-1</sup> data**
  - A. Patwa to continue with Saclay group on search efforts with 7-9 fb<sup>-1</sup> data
    - aim for observation or reach sensitivity of  $\tan\beta \sim 20$  for low  $m_A$



# Plan for the DØ Effort

- Complete MSSM Higgs Boson search with  $5.4 \text{ fb}^{-1}$  data
  - Provide support for  $7\text{-}9 \text{ fb}^{-1}$  MSSM  $h \rightarrow \tau\tau$  search
- In FY11, reduce to 0.7 FTE ( A. Patwa and S. Snyder)
- Transition remaining FTEs to ATLAS
- Strengthening ATLAS with expertise from Tevatron

Fiscal Year	FTE on DØ (core program)
2007	2.7
2008	2.0
2009	1.5
2010	1.5
2011	0.7
2012 (?)	0.3

# Personnel and impact of budget

- Current efforts on detector, performance, physics and detector R&D

Fiscal Year	Detector M&O	Software Performance Analysis Support	Physics Analysis	Upgrade R&D	D0	Total
2010	2.0	5.5	6.0	3.5	1.5	18.5
2012	2	5	6.7	2.5	0.3	16.5

- 3 Junior staff (2 on ATLAS, 1 on D0), 4 Post-docs
- To conform to the budget guidance, expect 2 FTE reduction by FY12
  - redirecting personnel to other projects and expected retirement
- Impact
  - Reduction in upgrade R&D by 1 FTE, would be forced to drop one R&D effort
  - Our original plan for strengthening physics analysis will be curtailedLimiting our role and impact in discovery physics  
Adding more postdocs for physics analysis would have been very effective.

## Summary of Plan for ATLAS at BNL (Core program)

- LHC physics analysis efforts
  - Leadership roles in ATLAS Physics Working Groups.
  - Focus on cutting edge ATLAS physics analyses
    - Maximize benefits from detector and software expertise, Tevatron analysis experience.
  - Commitment to support US ATLAS physics analysis
- Maintain the current level of commitments to ATLAS detector M&O, software and performance
  - Crucial roles in successful ATLAS operations
  - Commensurate with our contributions
- Detector R&D for ATLAS upgrade
  - Leading the LAr Calorimeter and Forward Muon upgrade
    - well matched to past experience
  - Established silicon strip R&D, aiming for the stave assembly center
    - would ensure US a leading role in silicon strip upgrade
  - Current funding may not support all three efforts for the long run.
    - will explore more generic R&D or other applications

# Some remarks

- BNL's current strong presence in ATLAS stems from our long standing contributions to ATLAS, technically and intellectually.
  - Requires continuing contributions to sustain the impact
  - BNL personnel are working very effectively in ATLAS because of our strong involvement in many areas
- The energy frontier remains to be the most fertile ground for discovery physics in the coming decade
  - We are driving the field forward, and harvesting the fruits of our labor.
- If US is going to be a strong presence in super LHC, BNL is positioned to lead some of the detector efforts.

# Summary

- ATLAS has demonstrated excellent detector performance with the collision data at 7TeV, and is ready to explore new energy frontier in 2010-2011.
- BNL ATLAS Program is making essential contributions to ATLAS operations, physics analysis and upgrade.
- Current budget guideline will require some reduction in effort in the next two years.

# Additional Slides

# Students

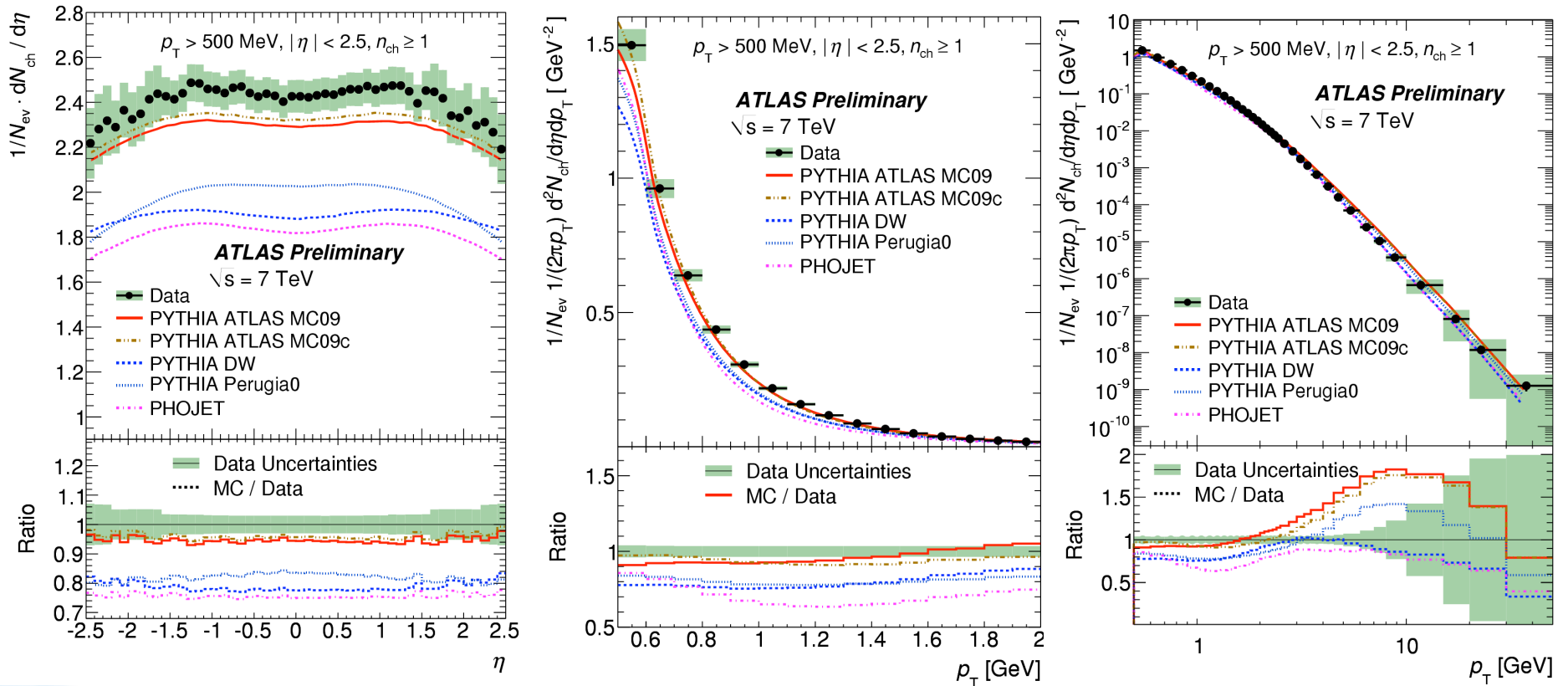
- Advantage of working with students
  - Utilize our expertise in detector, software and physics for educating the students
  - Students become more productive because of our involvement
  - Close collaboration with university groups
- Direct supervisory roles
  - One student from University of Oregon
    - BNL covers ½ cost through MOU
  - Two students from Iowa State
    - Previously similar MOU
    - Students are now only supported by DOE through Iowa State
    - BNL physicists' supervisory roles remain
  - Two students from Johannesburg
    - Johannesburg is an associated member of ATLAS through BNL
- Collaborative efforts with universities
  - No financial responsibilities
  - Working closely on the same physics analysis projects
    - Stony Brook, SMU, LaTech, Arizona ...

## FTEs supported by US ATLAS Operations Program in FY10 on detector M&O, upgrade, software, performance and computing at BNL

Projects	FTEs
Detector M&O	6.3
Upgrade R&D	4.2
Software/Validation	7.0
Analysis Support	0.5
Management	2.7
Tier-1/Facility	20.9
Total	41.6

engineers, software professionals and technicians

# Charged particle multiplicities in $pp$ interactions at $\sqrt{s} = 7$ TeV measured with the ATLAS detector at the LHC



# BNL Contributions to ATLAS Notes and International Conference Talks

- At the end of 2008, ATLAS produced a book **"Expected Performance of the ATLAS Experiment: Detector, Trigger and Physics"**
  - BNL Physicists contributed to 21 sections out of 76.
  - Reviewers for 5 sections, Editors of 6 sections
- Talks at International Conferences on behalf of ATLAS since 2008:
  - High Energy Physics: 7
  - Detector and electronics: 5
  - Software/Computing: 4
  - Heavy Ion/Forward Physics: 6